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18 November 1963

MEMORANDUM FOR THE RECORD

SUBJECT: C-Triple Prime Camera Modified for U-2

1. The conversion of C-Triple Prime Camera #51 from satellite operation to aircraft use was accomplished in the following manner:

a. IMC was changed by a factor of 2 to conform to the required V/H ratio change, from 130 nautical miles at 18,000 MPH to 13 nautical miles at 400 knots/hr. This was physically accomplished by redesigning the IMC cam.

b. Scan rate was changed to conform to the new cycle rate based on:

(1) new IMC as indicated above

(2) overlap change from 10 degrees on the existing satellite camera to 55%

(3) a vertical camera reorientation rather than the 15 degree stereo angle necessary in the satellite program.

c. Cycle rate changes were selected based on aircraft operating altitudes and velocities. Three selections or different rates were available to the pilot to cover all operating V/H combinations.

d. Shutter speeds were changed by manufacturing new slits to compensate for aircraft performance in roll and pitch and vibration levels. Normal satellite speeds were from 1/200 to 1/500 of a second. Since changing this requires only manual insertion of a slit the exposure raxte on the aircraft camera was all inclusive up to 1/2000 sec., in expodential steps.

e. The physical shape of the instrument was altered only to the extent of making it compatable for mounting in the existing Q-bay. This required no change in basic camera design, only the relocation of auxillary components.

f. The scan angle was changed from 70 degrees to 60 degrees because of Q-bay restrictions and existing window size. This was accomplished by cutting the scan cam to compensate for this 10 degree change and physically eliminating part of the platen.

g. The inertial compensating wheel was eliminated. This made it possible to operate with less power. Its prime function was to compensate for roll inertial inputs to the satellite vehicle. The input is insignificant in an aircraft and therefore eliminated.

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h. All auxillary TM, data recording and redundant command circuitry necessary to insure a "one shot" success was eliminated with no effect on the reliability of the camera.

i. An all titanium drum was used to compensate for the extreme temperature ranges expected (30 degrees F to 85 degrees F).

j. Because this is a fixed focus camera the lens position relative to the film plane was shimmed differently (by adding .005 inch shims) to compensate for the pressure change from 1 x 10 to the minus 2mm to 33.0mm of mercury.

k. Humidity control was not necessary only to the extent of preventing condensation on fast aircraft descents.

l. The aircraft vibration and g-loading was compensated for primarily by the addition of vibration isolators eliminating 98% of the 200-400 cps input from the aircraft and protection from up to 15 g's on the major axis of the aircraft.

m. Pilot control was accomplished by merely interfacing electrically with the Mark I driftsight control with no physical changes necessary on the control box. Use was made of existing lights and aircraft switches.

2. Tests conducted:

a. Thermal test:

During the thermal testing cycle (30 degrees to 140 degrees F) microscopic observations and measurements were taken of the autocollimated image. No focus change or image quality deterioration was detected.

b. Pressure testing:

Atmospheric pressure (1 to 1/100 atmosphere) conditions were introducted to the system. Evaluation was made of this focus and image using the previously described technique. Here again the analysis confirmed ~~to~~ the predicted changes (i.e., a linear response to pressure). Additionally, thermal and pressure were jointly introduced in order to observe any inter-reaction. This test also gave no unfavorable results.

c. Vibration and shock:

The camera was subjected to 1g shock and vibrated to 1g from 20-2000 cps for 30 minutes log sweep.

d. System dynamics:

To evaluate the system dynamics and vibration resolution photography was made to establish the resolution standard. The post-resolution photography showed no unaccounted for loss by dynamic vibration.

e. Electrical:

The electrical and mechanical checkouts were made continuously established levels of acceptance and therefore were considered fully qualified.

f. Photo/Optical:

The photo/optical testing included resolution at high and low contrast levels going through focus, format fogging for banding analysis, and the Dr. A. film flatness test and static through focus runs on the Mann bench and environmental lab simulator.

g. General:

Total camera cycles to achieve the test results were 9300. Successful reliability was experimented in actual flight runs and photographic results proved Itek's analysis on how to adapt this satellite camera to an aircraft. Itek feels that there is no area that can be identified as requiring further attention in order to increase reliability. All mechanical and electrical designs are proven reliable from past history. With the exception of interlocking circuits to protect the camera against vehichle power failure or surges, no changes are required.

3. Thirty Degree Stereo Configuration:

a. The interface of this system into the aircraft is basically the same as the Triple-Prime camera #51. The same changes will be made to this camera system, i.e., modifications to the IMC and scan cams because of the stereo angle and change in V/H values. It is mainly a problem of physical interface, but as of 18 November, 90% of the interface is complete. The same procedures will prevail to qualify the camera as noted above. The detail system design on slit widths and cycle rates are a function of operational requirements and can be changed as demonstrated at the option of the pilot and field crews.

b. Through a learning process on the C-Triple Prime Camera #51, improvements on mechanical interfane and electrical requirements will be incorporated to simplify field operations.

c. The system can remain on station for a minimum of 50,000 cycles with only normal field crew maintenance with confidence based on past performance of obtaining 100,000 cycles before M and O.

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